PROCESSING AND PRODUCTS

Effects of Diet and Feed Withdrawal on the Sensory Descriptive and Instrumental Profiles of Broiler Breast Fillets

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ABSTRACT Effects of diet and feed withdrawal times on the sensory profile and shear values of broiler breast meat were determined. Feeds were formulated with 3 dietary carbohydrate sources (corn, milo, and wheat). Birds (n = 192) were processed between 42 and 52 d of age. Feed was withdrawn for 0 or 8 h prior to pilot plant processing under simulated commercial conditions. Pectoralis major muscles were removed 4 h postmortem and frozen until evaluated. Thawed breast fillets were cooked in heat-seal bags immersed in 85°C water until an internal temperature of 80°C was reached. Color, shears, and sensory profiles (18 attributes) were determined. Meat from corn-fed birds required significantly less force to shear (6.0 kg) than meat from birds fed milo (6.7 kg) or wheat (7.1 kg). Feed withdrawal did not affect the flavor profile; however, meat from birds at 0 h feed withdrawal were darker and redder. Diet significantly affected the sensory profile. Brothy scores were significantly higher in meat from corn-fed birds than in meat from birds fed wheat or milo. Diet and feed withdrawal significantly affected sensory texture. Meat from wheat-fed birds was harder, more cohesive, and more chewy and exhibited larger particle size than meat from birds fed corn or milo. Moisture release values were lower and toothpack values were higher in meat from birds processed at 0 h feed-withdrawal time compared with meat from birds held 8 h without feed. Dietary carbohydrate source appears to have a measurable impact on flavor and texture of broiler breast meat.

(*Key words*: diet, feed withdrawal, sensory, shear value)

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INTRODUCTION

Meat quality is defined by a combination of many factors, but color and texture are especially important to consumers. Inherent characteristics of the animal, long- and short-term environmental influences on the animal, and processing parameters that affect the carcass or meat directly are all factors that influence meat color, texture, and flavor.

Age and genetic strain are 2 inherent factors that affect meat color and texture. Animal age may be important because myoglobin, the primary muscle pigment, tends to increase with age in chickens and other animals (Nishida and Nishida, 1985). Froning and Hartung (1967) reported this trend in poultry. They also reported that breast and dark meat of turkey becomes darker with age and that dark meat increases in redness as bird age increases. However, Smith et al. (2002) reported that color of broiler breast meat was not affected by age. Berri et al. (2001) found that genetic selection of broilers for increased meat yields also affected color by increasing breast meat lightness and decreasing redness. Meat texture of chickens may be affected by age (Shrimpton and Miller, 1960). Turkey meat tenderness was reported to increase as age increased, although all ages were within the range that turkeys are typically marketed (Stadelman et al., 1966; Ngoka et al., 1982).

Long-term environmental conditions, such as feed and housing conditions, may affect meat color. Dietary composition has been shown to affect muscle color of pigs (Rosenvold et al., 2001), cattle, and sheep (Geay et al., 2001). Supplemental yellow grease fed to cattle improves subjective redness scores of the longissimus muscle (Brandt et al., 1992). Conjugated linoleic acid fed to broilers darkens breast muscle and decreases redness (Du and Ahn, 2002). Nitrates in the diet increase the redness of chicken breast meat and turkey meat (Froning et al., 1969a). Similarly, broilers fed nitrate had significantly redder raw and cooked meat values than control birds (Froning et al., 1967). Dietary nitrates, nitrites, niacin, and riboflavin produced significantly redder fowl meat (Johnson and Froning, 1974). Mold culture material, which may simulate moldy feed, increases turkey muscle redness (Wu et al., 1994).

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Abbreviation Key: FWD = feed withdrawal; HA = hue angle.

Environmental conditions existing shortly before the animal is slaughtered, including stress, feed withdrawal, and transport affect meat color and texture. Stress is a well-known contributor to pale, soft, exudative muscle condition in pigs and to dark, firm, and dry muscle condition in cattle. The effect of stress on poultry muscle is less clear, however. For turkeys, cold stress is reported to increase lightness and decrease redness of muscle (Froning et al., 1978), but Babji et al. (1982) reported that although cold stress had no effect, heat stress increased muscle lightness and decreased redness. Excitation prior to anesthesia and slaughter increased darkness and redness of turkey muscle (Ngoka et al., 1982). During a transportation study, Froning et al. (1969b) reported that live turkeys that were exposed to exhaust fumes had increased meat redness. Transported turkeys had darker muscle color than turkeys not transported prior to slaughter (Owens and Sams, 2000). Neither transportation nor crating affected broiler muscle color (lightness or redness), although crating did affect hue angle (HA) of the muscle (Kannan et al., 1997). Although preslaughter feed withdrawal would seem to be a stressor for broilers, research results have been mixed. No effect due to feed withdrawal was shown for turkey or chicken muscle color (Ngoka et al., 1982; Kotula and Wang, 1994), although Smith et al. (2002) found that feed withdrawal produced lighter and less red broiler breast meat.

The ingredients that are incorporated into poultry feed can affect flavor of the meat. Herring meal at 5%, DL-methionine at 0.1% and choline chloride at 0.05% added to either low- or high-glucosinolate rapeseed meal rations resulted in odors and flavors described as fishy, rancid, unpleasant, and stale (Steedman et al., 1979; Hawrysh et al., 1980). The fishy aromatic was attributed to the added methyl groups from DL-methionine and choline chloride, which formed trimethylamine, a component responsible for fish odors. Off-flavors were also detected with the use of canola meal in the diet (Salmon, 1981).

There are many variables that may affect meat color, flavor, and texture. Some variables have been amply researched for broilers, whereas other factors have received less notice. The objective of this study was to determine the effect of 2 factors, diet and feed withdrawal, on color, texture, and flavor of broiler breast meat.

MATERIALS AND METHODS

Diet

The diets used in this study were previously reported by Smith et al. (2002). Briefly, 28-d-old broilers (n = 300) were obtained from a commercial growout house and transported to the University of Georgia's research farm. Twenty-five birds were placed into 12 total pens, and 3 different feeds were assigned to 4 pens each. The base feed was formulated to be isocaloric and consisted of soybean meal, poultry by-product meal, poultry fat, minerals, salt, and vitamins. Variations in the diets were accomplished by using a different grain as the major carbohydrate source. The grains and levels incorporated into the base feed were 1) 69.5% corn as a control, 2) 69.7% milo, or 3) 73.6% wheat.

Feed Withdrawal

Feed withdrawal schedules were based on the processing plan. Eight birds from 3 pens, each pen representing a different feed type, were processed each day for 4 d (42, 43, 44, and 45 d of age) during wk 1. Eight birds from the same pens in the same order were processed each day for 4 d in wk 2 (49, 50, 51, and 52 d of age). Twelve hours prior to processing, all birds were removed from feed for 2 h. Then feed was replaced for 2 h in an attempt to synchronize feeding behavior of the birds. Feed was withdrawn (FWD) from 4 randomly selected birds in each pen for 8 h prior to processing (8-h FWD), and water was withdrawn 4 h prior to processing. The other birds remained on feed (0-h FWD) and water. Four of these 0-h FWD birds were then randomly caught and transported (15 min) to the Russell Research Center for processing along with the four 8-h FWD birds.

Processing

The birds were electrically stunned (12 s, 50 V AC, 25 mA), necks were manually cut, and birds were bled for 2 min. Carcasses were scalded at 53°C for 2 min in an in-line scalder and then picked for 30 s in an in-line picker. Head and feed were removed before manual evisceration. Carcasses were rinsed for 30 s in a prototype inside-outside bird washer, chilled for 30 min in a revolving ice-water slush chiller, and then placed in plastic bags and refrigerated for approximately 3 h. Both left and right fillets were then removed from each carcass, individually tagged, and weighed. Fillets were placed in coded heat-seal bags and frozen at –30°C until cooking for sensory and shear evaluation. Fillets were essentially 4 h postmortem.

Raw Color Measurements and Cooking

Sample fillets for instrumental and panel evaluation were removed from the freezer, and the raw weight of each fillet in its bag was recorded. To derive the individual fillet weight, 10 empty bags were weighed, and the average bag weight was subtracted from the combined weight of the frozen fillet and bag. The bags were arranged single layer on a tray and thawed in a commercial refrigerator at 3 to 4°C for approximately 20 h.

Thawed samples were removed from the refrigerator and CIE L*, a*, and b* color measurements were made on the underside of the fillet through the bag using a Minolta CR-300[2] colorimeter. The colorimeter was calibrated through a clean bag with illuminant C. The average of triplicate readings was recorded. In addition to the CIE

[2]Minolta Chroma Meter 300, Minolta Corp., Ramsey, NJ.

L*, a*, and b* values, the HA values were calculated from a* and b* values (HA = $\tan^{-1}$ b*/a*). Fillets were cooked in their bags for 35 min on a commercial range by immersing the bags (4 fillets per container) in 11-L stainless steel vessels filled with 6.8 L of water heated to 85°C. In preliminary trials, it was determined that heating for 35 min resulted in an internal temperature of 80°C. The end-point temperature of the heaviest fillet was measured to ensure adequate cooking for each sample set. After being cooked, fillets were removed from the cooking vessel and tempered at room temperature for 5 to 8 min. Fillets were removed from the bags, and cooked weights were recorded. Cook yield was calculated as (raw weight – average weight of 10 bags) – cook weight/(raw weight minus average weight of 10 bags) × 100.

Cooked Color and Shears

Two parallel strips, 1.9 cm wide, were removed from each fillet using the technique of Lyon and Lyon (1991). One strip was used for color measurement and shear value analysis, and the other strip was for panel flavor and texture evaluation. Assignment of the 2 strips within the breasts for instrumental and panel tests was alternated between replications.

Immediately after cutting, the color of the strip assigned to instrumental tests was measured on the inside cut surface using the colorimeter. Triplicate readings were averaged and recorded. Shear force values on the same 1.9 cm wide strip from each fillet were obtained with a Warner-Bratzler blade attached to a TA-XT2 Texture Analyzer[3] fitted with a 25-kg load cell (50-kg capacity). The height of each strip was measured at the 2 points of shearing by using calipers, which gave a known width and height of each strip at the point of shearing (kg/cm^2). The shear test was set for blade travel at test speed of 4 mm/s. Attributes associated with the instrumental shearing procedure were shear force (kg), gradient, area under the curve, and shear force divided by sample dimensions (kg/cm^2).

Sensory Analysis

Sensory flavor and texture profiles were determined on the second 1.9 cm wide strip removed from each fillet (n = 8). The adjacent muscle sections of 1 or 2 randomly selected fillets were used for the ninth panelist. Sample strips from each cooked breast were placed in prewarmed 178-mL (6-oz) glass custard cups that were nested in styrofoam bowls to maintain serving temperature (55°C). Sample containers were coded with 3-digit numbers and presented to panelists (n = 9) in individual sensory workstations equipped with computers for data collection using the Compusense*five* Sensory Analysis System.[4] Panelists evaluated the intensity of the sample attributes and

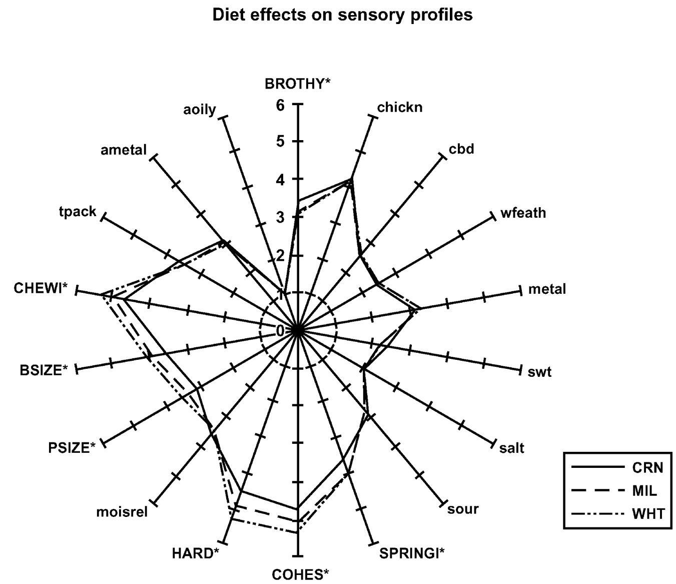

FIGURE 1. Spider plots of mean values of 18 sensory attributes describing the sensory flavor and texture of broiler breast fillets from birds fed diets containing either corn (CRN), milo (MIL), or wheat (WHT). Values are pooled over feed withdrawal times (0 and 8 h) and over 3 replications. Each attribute is represented by a ray that extends from the center point and represents the 0- to 15-cm line scale truncated to the maximum values used by panelists. Mean scores of each treatment for each attribute are plotted and then connected to provide a visual graphic profile of sensory and texture attributes. Abbreviations for each attribute are presented in Table 1.

marked their responses on 15-point line scales, low (1) to high (15). Sensory flavor, basic tastes, texture, and afterfeel or aftertaste attributes (Figure 1) and definitions used by the descriptive panel to evaluate cooked breast meat are detailed in Table 1. The flavor and texture lexicon had been developed by a trained descriptive sensory panel during previous studies (Lyon, 1987; Lyon et al., 2001; Lyon and Lyon, 2000). During orientation sessions, the lexicon and panel performance were validated. Sensory evaluations were replicated 3 times. Sample order presentations to panelists were randomized across sessions.

Statistical Analysis

Samples in this study were from birds used in a previous study. Smith et al., (2002) analyzed the data as an experimental design of 8 × 3 × 2 (age by diet by feed withdrawal) with 4 birds in each cell (n = 191, from 192 birds processed minus one destroyed bird) to determine significance of main effects (age, diet, and FWD) on raw carcass weight, raw fillet weight, and raw color measurements before freezing. Using general linear models design, no effects were found due to age, or wk 1 vs. 2, or fillet side (right vs. left). No significant differences were found for carcass weight, fillet weight, or raw L*, a*, or b* color values between wk 1 and 2, indicating that there did not appear to be any skewed results resulting from random selection of birds over the 2-wk period. It was also found that age of birds (42 to 52 d) over the processing

[3]Texture Technologies, Scarsdale, NY.
[4]Compusense, Inc., Ontario, Canada.

TABLE 1. Sensory attributes[1] and definitions used to profile the flavor and texture of broiler breast meat

Attribute	Abbreviation	Definition
Flavor		Aromatic taste sensation associated with
1. Brothy	brothy	Meat stock
2. Chickeny/meaty	chickn	Cooked white or dark chicken muscle
3. Cardboardy	cbd	Cardboard, wet paper
4. Wet feathers	wfeath	Wet poultry feathers
5. Bloody/serumy/metallic	metal	Raw or "rare" lean meat/serum
Basic tastes		Taste on tongue stimulated by
6. Sweet	swt	Sugar and high-potency sweeteners
7. Salty	salt	Sodium salts, especially sodium chloride (table salt)
8. Sour	sour	Acids
Texture		
9. Springiness	springi	Degree to which sample returns to its original shape after partial compression (low to high)
10. Cohesiveness	cohes	Degree to which sample deforms rather than breaks—first bite (low to high)
11. Hardness	hard	Force required to compress the sample with molars—first 2 bites (low to high)
12. Moisture release	moisrel	Amount of moisture (liquid/fat) coming from sample during first 10 chews (low to high)
13. Particle size	psize	Size of meat particles in wad during chewdown (small/mealy to large/fibrous)
14. Bolus size	bsize	Size of wad at 25–30 chews (small to large)
15. Chewiness	chewi	Amount of work required to chew the sample (low to high)
16. Toothpack/residual particles	(tpack)	Amount of particles left in teeth/mouth after point of swallow (none to much)
Afterfeel/aftertaste		
17. Metallic	ametal	Sensation of metals in mouth; tinny; iron
18. Oily mouthcoat	aoily	Feeling or coating detected in the mouth due to oil or grease

[1]Sensory attribute intensities were scored on a scale of 1 = low to 15 = high.

period (2 wk) had no significant effect on raw carcass weight, raw fillet weight, or raw color values. Additionally, no interactions were observed. Subsequently, in this study, effects of bird age and fillet side were not considered. Color measurements and shear data were analyzed using general linear models design with main effects of diet and feed withdrawal and interaction of diet × feed withdrawal. Means were separated using least square means with Tukey's mean separation procedures of SAS software, significance $P < 0.05$ (SAS Institute, 1998). Sensory data were analyzed using PROC MIXED with diet and feed withdrawal as fixed effects and session and panelists as random effects. Least square means were generated, and PDIFF was assessed for significance. Means were used to generate spider plots of sensory profiles.

RESULTS AND DISCUSSION

Cooked Yield

The main effect of feed withdrawal was not significant for cooked yield (Table 2). Diet was significant ($P < 0.05$). Birds fed the wheat-based diet had lower raw and cooked fillet weights ($P < 0.05$). There were no significant differences in raw or cooked fillet weights of birds fed corn or milo. Weights of frozen fillets combined across feed withdrawal times ranged from 127.25 g (wheat) to 140.93 g (corn). Cooked weights followed the same pattern. However, cooked yield was not affected by diet or feed withdrawal. The weight differences observed for raw and cooked weights between wheat and the other diets, corn and milo, could merely reflect the arbitrary selection and grouping of the birds for diet-type and selection within the diet groups for assignment to feed withdrawal schedules. Cooked yields of the deboned fillets averaged about 73.48% across groups.

Color

There were significant treatment effects on thawed, uncooked, and cooked color values due to diet, feed withdrawal, and diet by feed withdrawal interaction (Tables 3 and 4). L* values (lightness) ranged from 44.61 for fillets from birds fed the corn diet with 0-h FWD to 48.20 for fillets from the wheat diet with 8-h FWD. The average L* value of 47.12 for fillets from the wheat-based diet was significantly higher (i.e., lighter in color) than for corn-

TABLE 2. Mean values for weights and cooked yield[1] of Breast meat from broilers fed corn, milo, or wheat-based diets and subjected to feed withdrawal of 0 or 8 h[2]

Diet	Raw weight (g)	Cooked weight (g)	Yield (%)
Corn	140.03^a	104.63^a	74.72^a
Milo	139.62^a	103.13^a	73.68^a
Wheat	127.75^b	92.48^b	72.03^a

[a,b]Means within columns followed by a different superscript are significantly different ($P \le 0.05$).

[1]Yield was calculated as weight of cooked breast fillet divided by weight of thawed, uncooked breast fillet × 100; n = 64.

[2] Feed withdrawal time did not significantly affect weights or yield; therefore, data were pooled.

TABLE 3. Means (±SE) of CIELAB[1] color values[2] of thawed, uncooked breast meat from broilers fed corn, milo, or wheat-based diets and withdrawn from feed for 0 or 8 h before slaughter

	L*		a*		b*		Hue angle	
	Feed withdrawn (h)		Feed withdrawn (h)		Feed withdrawn (h)		Feed withdrawn (h)	
Diet	0	8	0	8	0	8	0	8
Corn	$44.61^{b,y} \pm 0.44$	$45.78^{b,x} \pm 0.37$	$2.63^{a,x} \pm 0.19$	$1.78^{b,y} \pm 0.14$	$3.22^{a,x} \pm 0.20$	$3.12^{a,x} \pm 0.23$	$49.91^{a,x} \pm 2.93$	$51.60^{a,x} \pm 5.31$
Milo	$44.36^{b,y} \pm 0.51$	$46.58^{b,x} \pm 0.39$	$2.81^{a,x} \pm 0.21$	$2.30^{a,x} \pm 0.16$	$0.91^{b,x} \pm 0.14$	$0.87^{c,x} \pm 0.16$	$21.40^{b,x} \pm 3.90$	$22.54^{b,x} \pm 4.15$
Wheat	$46.05^{a,y} \pm 0.31$	$48.20^{a,x} \pm 0.41$	$2.21^{a,x} \pm 0.17$	$1.35^{b,y} \pm 0.17$	$1.31^{b,x} \pm 0.14$	$1.64^{b,x} \pm 0.19$	$33.00^{b,x} \pm 3.71$	$28.91^{b,x} \pm 8.14$

[a,b]Means within columns with differing superscripts are significantly different ($P \leq 0.05$).

[x,y]Means within variables within rows with differing superscripts are significantly different ($P \leq 0.05$).

[1]L* = lightness; a* = redness; b* = yellowness; hue angle is calculated as $\tan^{-1}$ b*/a*.

[2]n = 32.

and milo-based diets (pooled over feed withdrawal times). These effects were carried over to the cooked samples (inside cut surface) with the fillets from the wheat-based diet maintaining a significantly higher L* value (80.24) than fillets from the corn or milo-based diet (Table 4). Fillets from 8-h FWD birds had significantly higher L* values (lighter) whether cooked or uncooked and continued the trend of lighter fillets resulting from feed withdrawal stress reported by Smith et al., (2002).

The a* values (redness) of the thawed uncooked samples were significantly different due to diet and FWD time (Table 3). Uncooked fillets from wheat-based diets were less red (1.78) compared with the corn and milo-based diets (2.21 and 2.56, respectively). The color differences for the cut surface of the cooked fillet indicated that the fillets from birds fed the milo-based diet were significantly redder (higher a* values) than fillets from birds fed the corn or wheat diet. Whether uncooked or cooked, fillets from 0-h FWD birds were significantly redder than fillets from 8-h FWD.

The CIE b* values measure yellowness. Raw and cooked fillets from birds on the corn-based diet were significantly more yellow than fillets from birds fed milo or wheat (Tables 3 and 4). Uncooked fillets from birds fed the wheat-based diet were significantly more yellow than uncooked fillets from birds fed the milo-based diet. This difference was not evident in the cooked fillets. Uncooked fillets from 8-h FWD were significantly more yellow than fillets from 0-h FWD birds, but the differences were negated by cooking.

The HA is a calculated value ($\tan^{-1}$b*/a*) describing color in degrees on the CIELAB color space model, beginning on the a* axis and proceeding counterclockwise around the axis. Uncooked fillets from birds on the corn-based diet had significantly higher HA values than uncooked filled from birds fed either milo or wheat, which did not differ (Table 3). When cooked, all samples were significantly different from each other (Table 4). HA values ranged from high to low in the order of corn > wheat > milo. Feed withdrawal had no effect on HA values of uncooked samples, whereas for cooked samples the HA values were significantly higher in samples from 8-h FWD birds.

Shear Curve Parameter

Feed withdrawal had no significant effect on any of the shear curve parameters of the cooked meat. There were significant effects due to diet on total force to shear (kg), shear force expressed on a unit basis of sample height × width (kg/cm^2), gradient, and area under the curve. The breast fillets from wheat and corn-fed birds were significantly different from each other but not different from the milo-fed birds. Breast fillets from wheat-fed birds required significantly more force to shear (7.19 kg) compared with breasts from corn-fed birds (6.00 kg). This equated to a 2.19, 2.03, and 1.82 kg/cm^2, respectively, for breast meat from birds fed wheat, milo, and corn.

Gradient is the slope of the curve as the blade shears through the meat sample. The gradient for the corn-fed

TABLE 4. Means (±SE) CIELAB[1] color values[2] for cooked breast meat from broilers fed corn, milo, or wheat-based diets and withdrawn from feed for 0 or 8 h before slaughter

	L*		a*		b*		Hue angle	
	Feed withdrawn (h)		Feed withdrawn (h)		Feed withdrawn (h)		Feed withdrawn (h)	
Diet	0	8	0	8	0	8	0	8
Corn	$79.00^{b,y} \pm 0.23$	$79.87^{a,x} \pm 0.19$	$1.78^{b,x} \pm 0.08$	$1.26^{b,y} \pm 0.08$	$11.52^{a,x} \pm 0.20$	$11.71^{a,x} \pm 0.25$	$81.12^{a,y} \pm 0.43$	$83.72^{a,x} \pm 0.45$
Milo	$79.29^{b,x} \pm 0.23$	$79.86^{a,x} \pm 0.21$	$2.18^{a,x} \pm 0.08$	$1.74^{a,y} \pm 0.09$	$9.93^{b,x} \pm 0.14$	$9.74^{b,x} \pm 0.10$	$77.51^{b,y} \pm 0.49$	$79.77^{b,x} \pm 0.62$
Wheat	$80.13^{a,x} \pm 0.25$	$80.33^{a,x} \pm 0.24$	$1.89^{b,x} \pm 0.11$	$1.32^{b,y} \pm 0.09$	$9.59^{b,x} \pm 0.09$	$9.85^{b,x} \pm 0.15$	$78.77^{b,y} \pm 0.65$	$82.28^{a,x} \pm 0.59$

[a,b]Means within columns with differing superscripts are significantly different ($P \leq 0.05$).

[x,y]Means within variables within rows with differing superscripts are significantly different ($P \leq 0.05$).

[1]L* = lightness; a* = redness; b* = yellowness; hue angle is calculated as $\tan^{-1}$ b*/a*.

[2]n = 32.

TABLE 5. Means (±SE) of Warner-Bratzler shear curve parameters of cooked broiler breast meat from birds fed wither a corn-, milo-, or wheat-based diet and withdrawn from feed 0 or 8 h before slaughter

Diet	Time to peak max	Force to shear (kg)	Force to shear (kg/cm^2)	Gradient	Area under curve
Corn	4.64 ± 0.26	6.00^{b} ± 0.26	1.82^{b} ± 0.08	1.11^{b} ± 0.03	26.93^{b} ± 1.38
Milo	4.83 ± 0.26	6.74^{ab} ± 0.23	2.03^{ab} ± 0.06	1.22^{a} ± 0.03	31.41^{a} ± 1.33
Wheat	4.77 ± 0.28	7.19^{a} ± 0.29	2.19^{a} ± 0.88	1.27^{a} ± 0.04	33.58^{a} ± 1.65

[a,b]Means within columns with differing superscripts are significantly different ($P \leq 0.05$); n = 32.

meat was significantly lower than for meat from birds fed milo or wheat. There was less force to shear detected over the distance that the blade traveled for fillets from corn-fed birds compared with fillets for birds fed the other 2 diets. The area under the curve is an indication of the total work needed to cut through the sample fibers. Breast meat from milo- and wheat-fed birds required significantly more work to shear than did meat from corn-fed birds. However, the mean shear values based on total kilograms of force for meat from the 3 diets would be in the range that equates to "slightly to moderately tender" by sensory panels (Lyon and Lyon, 1991). Even though there was a statistically significant difference, the practical significance may be questionable. The carcasses were approximately 4 h postmortem when breast fillets were removed, and so the effects of early deboning times and other treatments such as electrical stimulation on the texture profile would warrant further study.

Sensory

Sensory data were initially analyzed for panel performance (sensitivity, agreement, cross-over effects) using a variety of procedures. Acceptable levels of performance by all panelists were indicated. No panelists were clear outliers on any of the 18 scales or attributes. Data were then analyzed using a mixed model with diet and FWD times as fixed effects and session, panelists, and panelists within sessions as random effects. Results indicated that only toothpack was affected by FWD. Fillets from 0-h FWD birds scored higher on toothpack than fillets from 8-h FWD birds.

Significant effects due to diet were found for the brothy flavor notes. Meat from birds fed corn was scored significantly higher for brothy than was meat from birds fed milo or wheat. Six texture attributes were significantly different due to diet. Fillets from birds fed the corn diet were significantly less springy and less chewy and had smaller particle size and bolus size than fillets from birds fed a milo or wheat-based diet. Fillets from birds fed the corn diet were also less cohesive and less hard than fillets from wheat-fed birds but not different from fillets from milo-fed birds for these attributes. The sensory texture attributes correlated with the instrumental parameters of the Warner-Bratzler curve, which indicated that the corn-based diet affected texture of the cooked fillets (Table 5). The oily aftertaste attribute that had been selected by the panel was scored less than 1.00 on the 0 to 15 scale and, therefore, was not of any consequence to the sensory profile of the products.

The effects of dietary carbohydrate source appeared to have statistically significant measurable effects on breast meat quality. Corn-based diets had less springiness and chewiness by sensory evaluation and less force to shear, lower gradient, and less area under the curve by instrumental evaluation. The effects of FWD indicated that thawed uncooked fillets and cooked fillets from birds that were removed from feed for 8 h prior to slaughter were lighter and less red. Consumer studies should be conducted to determine the effects of these differences on acceptance.

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